STATEMENT OF WORK

RESEARCH AND DEVELOPMENT IN EO AND IR FOR ADVANCED RECONNAISSANCE (ISR) AND ELECTRONIC WARFARE (EW) PROTOTYPES FOR NAVY/MARINE CORPS TACTICAL AIRCRAFT

1. INTRODUCTION/BACKGROUND

The Optical Sciences Division of the Naval Research Laboratory carries out a broad range of advanced technology development activities in support of Naval Forces as well as other Defense Department components. The programs are aimed at providing new and advanced capabilities for aircraft, surface and subsurface platforms, defense installations, force components, and individual service personnel. The activities include: (a) research and development of advanced technology concepts, early test and evaluation of prototype systems, and evaluation of advanced concept aircraft Electronic Warfare (EW) Self-Protection and Intelligence, Surveillance, Reconnaissance (ISR) systems, (b) identification of requirements for developing solutions to threat systems, including development of technical specifications to accommodate aircraft platform requirements, (c) technical insertion of new technologies into current and near term EW Self Protection and ISR systems in order to provide solutions to advanced threat systems, (d) analysis and evaluation of promising technology, including development of one-of-a-kind measurement and evaluation processes, (e) development of algorithms and techniques for implementation in advanced systems, (f) modeling and simulation to aid development programs, and technical management and engineering assessment to aid the transition of new technologies into System Development and Demonstration phase, primarily for Navy/Marine Corps acquisition programs.

2. SCOPE OF WORK

The purpose of the contract is to acquire the expertise of highly skilled personnel possessing the qualifications described in enclosure (1), equipment and facilities to support the Optical Sciences Division with a comprehensive, integrated program of systems engineering, technical engineering, engineering analysis, independent assessments, and research activities pertaining to the development, measurement, and evaluation of new and existing airborne systems and avionics The required engineering efforts and areas of technical investigation will be broad, but will emphasize the development of electronic systems and embedded software to facilitate the operation and optimum exploitation of visible, electro-optic, and infrared (VIS/EO/IR) sensors and systems. While the emphasis is on VIS/EO/IR technologies, alternative approaches using technologies such as acoustics and radio frequencies may be investigated from time to time to determine if more effective solutions could be achieved using other than VIS/EO/IR. Also, the use of optical technology in areas such as materials development, information processing, bio-engineering, and communications may also be investigated.

The principal objective of the program is optimal system performance. However, size, weight, cost, and system efficiency are important, often critical, factors and the programs may emphasize new technologies to improve these characteristics.

The Government anticipates that the work to be performed under this contract will be performed at the contractor's site, the Naval Research Laboratory (NRL), Naval Air Systems Command facilities at Naval Air Station (NAS) Patuxent River, MD, Naval Surface Warfare Center Dahlgren, VA, NAS Point Mugu, CA and NAS China Lake, CA, as well as other government sites in

pursuit of NRL objectives. Testing of components and prototypes may occur at Government bases and test ranges such as these and special facilities such as the White Sands Missile Range, Aberdeen Proving Grounds, Marine Corps Air Station Yuma, and Naval Surface Warfare Center Crane. Deliverables required under this contract shall include monthly cost and progress reports; a final technical report; both computer and non-computer based algorithms, source code, executable code and documentation; design drawings, hardware, design documentation, plans and manuals and task specific technical reports in accordance with attached DD Form 1423s.

3. TASKS

3.1 EVALUATION OF CURRENT VIS/EO/IR TECHNOLOGIES IN EW AND ISR SYSTEMS

SUBTASK 3.1.1 – ANALYSIS OF CURRENT EO/IR COMPONENT LIMITATIONS

The continuing development of VIS/EO/IR technology, as well as related technologies such as high speed and high capacity processing, provides system and prototype developers new opportunities for improvements in VIS/EO/IR systems. These new technologies can benefit various EW and ISR systems under development or deployed. The system benefits of using new VIS/EO/IR technology could be in performance, size, weight or required power, depending on the particular function of the system, or could be by providing new functions. Under this task the contractor shall identify those characteristics of existing or developmental systems that are limited by the VIS/EO/IR technology in use and shall identify the technology areas that could lead to substantial system improvements. The contractor shall organize this information in a format such that assessments can be made from the viewpoint of the system functions and characteristics.

SUBTASK 3.1.2 – ANALYSIS OF NEW TECHNOLOGY IMPACT

Subtask 3.1.2.1 Specific Performance, Weight, Power, and Cost Estimates

The contractor shall assess what level of improvement could be made using new VIS/EO/IR technologies for new system designs or incorporating these technologies in existing or developmental systems. The contractor shall quantify the specific performance features, weight savings, improved power efficiency, reduced size, or reduced cost. The contractor shall assess what the negative impact, if any, there would be on other system characteristics by introducing each new technology and shall estimate the level of the penalty. The contractor shall also consider what the durability and reliability of the new technologies may be and identify ways to mitigate any negative aspects.

Subtask 3.1.2.2 Analysis of Risk for Incorporated Improvements

The contractor shall perform an assessment of the risk to achieving the improved VIS/EO/IR system performance and cost as well as the risk to the program development schedule of introducing the new technology. The assessment shall consider both hardware and software risks. The Contractor shall develop a risk assessment of using alternatives and prepare a set of lower risk technical options. These options shall identify the impact on the system performance, reliability, cost, and schedule. The Contractor shall develop a set of metrics and milestones for the program options that would guide the decisions for selecting a lower risk alternative. Efforts associated with this task shall include a modeling and simulation capability suitable for both EW and ISR systems. The contractor shall develop plans and recommendations on how such a modeling and simulation capability could best be utilized to reduce design risks and to optimize the number and types of field tests required.

SUBTASK 3.1.3 – ALTERNATIVE TECHNOLOGIES

Subtask 3.1.3.1 Impact of Alternative Technologies

The contractor shall examine the possibility of using alternative technologies such as acoustic or radio frequency or other technology devices in lieu of VIS/EO/IR components or systems. The contractor shall assess their impact on the performance objectives, size, weight and power. The contractor shall assess their impact on the concept of operations and shall assess the reliability and maintainability of the alternative. The contractor shall emphasize use of the systems on aircraft platforms, both rotary and fixed wing. The fixed wing platforms should be the modern tactical aircraft such as the F-18 and special aircraft such as the EA-6B and the EA-18G.

Subtask 3.1.3.2 System Simulations in the Evaluation of VIS/EO/IR and Alternative Technologies

The contractor shall identify and exercise existing simulations to analyze the system alternatives. The contractor shall explore planned concepts of operations for the intended system platforms. The contractor shall summarize the results of these simulations in a manner that allows for direct comparisons of the as well as scenarios that are not amenable to direct analysis or where existing data are inadequate to compile a comprehensive assessment of the system options. The contractor shall use simulation results only for those simulations that have been validated by a competent authority and use other simulations only as a guide to support other assessment techniques.

SUBTASK 3.1.4 – PROVIDE RECOMMENDATIONS AND DOCUMENTATION

The contractor shall use or modify the metric developed in 3.1.2.2 for assessing the relative merits of using the VIS/EO/IR components or systems as well as the alternative systems. The contractor shall apply the metric to the identified options and shall assemble the results in a format suitable for comparing the various technologies. The rationale for the metric and the ranking of each option shall be discussed. The contractor shall provide a recommendation for which alternative system should be pursued. A separate assessment shall be provided for each candidate application within the EW and ISR mission areas.

3. 2 CONDUCT LABORATORY ANALYSIS OF VIS/ VIS/EO/IR TECHNOLOGY

SUBTASK 3.2.1 – EVALUATE EXISTING SYSTEM COMPONENTS AND THEIR CAPABILITIES

Subtask 3.2.1.1 Laboratory Evaluations

The contractor shall test and evaluate the technologies implemented in the existing systems and identify the components that govern system characteristics such as size, weight, power, bandwidth, resolution, range, system noise, mean time between failure, and cost. The contractor shall evaluate whether VIS/EO/IR component upgrades are available that could be introduced to improve system characteristics. The contractor shall also examine tradeoffs that could be made that would yield major improvements in some system characteristics with only minor sacrifice in others.

Subtask 3.2.1.2 New VIS/EO/IR System Needs

The contractor shall exploit various threat systems so that their functionality can be understood. This understanding will be applied to the development of software/hardware models. The hardware and/or software models will ultimately be utilized to identify needed countermeasure systems and to verify countermeasure techniques. This activity includes laboratory electro-optical measurements and/or field measurements at contractor or government facilities. The activity includes the use and test set-up of electro-optic instrumentation such as lasers, AO modulators, optics, radiometers, etc. as well as digital and analog electronics. The contractor shall develop the data acquisition hardware and software required for the testing.

The contractor shall review situational awareness and hostile ground fire detection and classification needs/improvements. The capability to perform these functions shall be assessed for

current as well as planned systems, and any deficiencies or weaknesses identified. The possibility of addressing these deficiencies or weaknesses with VIS/EO/IR systems shall be identified together with a description and the system requirements.

The IR countermeasure optimization program relies heavily on modeling and simulation. The contractor shall perform laboratory measurements of countermeasure effects to existing threat systems and compare those results to model predictions. Model agreement and/or model deficiencies and identified improvements shall be corrected as needed.

The contractor shall support the exploitation of foreign tactical threats to naval aviation and foreign EO/IR/UV sensor systems that may become available. The contractor shall assess the impact of the exploitation results on the design and testing of current and developmental systems.

SUBTASK 3.2.2 – EVALUATE NEW SYSTEM COMPONENTS AND THEIR CAPABILITIES

The contractor shall review current developments in relevant component technologies and shall assess the system impact of introducing new or alternative components. The contractor shall conduct laboratory evaluations of new VIS/EO/IR technologies to verify their suitability. The contractor shall identify any improvements or variants in the technology and shall verify their characteristics through laboratory testing. In addition to the performance assessments, the contractor shall assess the cost and the schedule for introducing the new technology.

Based on the results of the testing and evaluation, the contractor shall then develop a set, or sets, of plans for developing engineering solutions utilizing these new technologies. The contractor shall identify any deficiencies in the measurements and analyses needed to adequately assess the new technologies and shall perform measurements and analyses to support correcting these deficiencies. The contractor shall perform the measurements and analyses as directed by the COR.

The contractor shall gather data, perform analysis, and develop algorithms for situational awareness and hostile ground fire detection and classification. The contractor shall utilize data obtained from fielded/proposed systems as well as from collateral sensors.

SUBTASK 3.2.3 – INVESTIGATE AND DEVELOP ALGORITHMS AND SOFTWARE/HARDWARE METHODS TO ENHANCE CAPABILITY

The contractor shall develop algorithms for effective processing of sensor data to improve real time functionality of systems and aid in the exploitation and analysis. These algorithms shall be developed to augment commercial products or as new stand-alone modules. The contractor shall develop algorithms for effective screening of both still and video frames of imagery for real time exploitation and analysis. These algorithms shall be developed only in those cases where commercial products are not available. The contractor shall optimize the data display for ease of use and clarity of presentation to the image analyst. The purpose of these displays shall be to facilitate target detection and identification and to provide simple means of extracting small data segments for rapid transmission. The underlying principles of the algorithms shall be fully described in technical reports submitted upon completion of each task.The contractor shall optimize the displayed data for ease of use and clarity of presentation to the analyst. The algorithms shall be to facilitate target detection, identification and tracking and shall be aimed at real time output of lower bandwidth information. The underlying principles of the algorithms shall be fully described in technical reports submitted upon completion of each task. The contractor shall utilize techniques such as single frame matched filtering, frame differencing, and temporal averaging under current Windows and Linux operating systems.

The contractor shall assess what software modifications may be necessary to augment fielded systems to achieve enhanced situational awareness and a hostile ground fire detection and

classification capability. The contractor shall identify and incorporate any software improvements into the IR countermeasure optimization program.

SUBTASK 3.2.4 – PROVIDE RECOMMENDATIONS AND DOCUMENTATION

The contractor shall identify system improvements or new capabilities that can be introduced and quantify both the benefits and drawbacks to their introduction. The contractor shall use or modify the metric from 3.1.2.2 for weighting the system characteristics with the degree of improvement (or degradation) to provide a measure of the value of the technologies. At the direction of the COR, the contractor shall develop program plans for the introduction of those technologies having the greatest benefit to the systems under consideration. The contractor shall assess the applicability of the improvements and capabilities to ISR systems and programs such as SHARP, Angel Fire, and WAPSS as well as EW systems and programs such as AAR-47, DIRCM, TADIRCM, and DoN LAIRCM.

3.3 PROTOTYPE VIS/ VIS/EO/IR SYSTEM DESIGN AND DEVELOPMENT

SUBTASK 3.3.1 – DEVELOP PROTOTYPE OPTICAL COMPONENTS, SENSORS, AND SYSTEMS

At the direction of the COR, the contractor shall prepare detailed schedule and cost projections for developing selected components and systems that can provide a significant improvement as indicated by the metric defined in Subtask 3.1.2.2 and following. The contractor shall identify specific measurements or analyses that must be completed to assess the risk to successful development of these components. At the direction of the COR, the contractor shall execute selected tasks or analyses. Pending further review by the COR, the contractor shall develop components and sensors and demonstrate their functionality.

The contractor shall review and analyze mission profiles and Intelligence Agency threat documents relevant to imaging seekers. The analysis shall include a scientific/engineering evaluation based on understanding functionality for the purposes of surrogate/model development/improvements.

The contractor shall review situational awareness and hostile ground fire detection approaches and develop designs for prototype components, sensors, and/or systems to perform these functions.

SUBTASK 3.3.2 – DEVELOP PROTOTYPE SYSTEM SOFTWARE AND HARDWARE

The contractor shall modify or develop the control software necessary to integrate new components into prototype systems. The contractor shall integrate both hardware and software into the target system and verify the improvement in system capability. The contractor shall modify or develop and then demonstrate software to perform the data analysis of the output from the improved system. Software shall be developed in C/C++ and utilize Windows application development tools such as Borland C++, Borland Delphi, and Microsoft Visual C++. Real time software for aerospace applications shall be developed under the VxWorks operating system environment.

The contractor shall support the design, development and analysis of embedded hardware and software systems including radar, EO/IR threat warning, and reconnaissance systems. The contractor shall perform design of needed digital systems utilizing VHDL, FPGA, ASIC, VLSI, VME, PCI, and Ethernet.

The contractor shall develop real time software and real time tracker hardware for imaging seeker surrogate development. The contractor shall develop scene injection software and hardware. The contractor shall perform field and laboratory measurements as needed. The contractor shall become proficient in the use of digital models using the ISAMS/DISAMS architecture and shall develop advanced algorithms for functions such as target acquisition and tracking.

The contractor shall develop prototype software necessary to achieve an enhanced situational awareness and hostile ground fire detection and classification capability.

SUBTASK 3.3.3 – DOCUMENT HARDWARE AND SOFTWARE

The contractor shall develop documentation to describe the hardware and shall develop the source code for the software into a standard commercial format. The hardware documentation shall include drawings that specify critical design features and shall specify any unique processes required in the assembly and operation of the new components. The documentation shall include any test data acquired during the development and testing stages

SUBTASK 3.3.4 – DEVELOP AND DOCUMENT CONOPS FOR THE PROTYPE SYSTEM

The contractor shall analyze the operational scenario and identify any modifications that should be made to the operational use of the prototype system. The analysis shall include details of the new capabilities that support the recommended changes. The contractor shall also recommend changes to the maintenance program and the logistics plan that should be made to accommodate to the improved system.

3.4 PROTOTYPE VIS/EO/IR SYSTEM TEST AND EVALUATION

SUBTASK 3.4.1 – TEST PLANNING

The contractor shall develop test plans including schedules, personnel requirements, and budgets, shall identify special facilities and equipment required, identify test range requirements if needed, provide coordination with other Government agencies, and identify any unique licensing requirements needed to support the tests. The contractor shall coordinate with other test participants and support organizations on any safety issues that must be addressed and for any training needed or special permits that must be obtained. The contractor shall develop a schedule of tasks that must be accomplished to allow the testing program to proceed without delays due to omission of any requirements needed to allow the testing to proceed. The plan shall provide for the testing of any and all characteristics of the systems developed that are expected to be improved or have been changed, including performance, reliability, and environmental response.

SUBTASK 3.4.2 – FIELD TEST EXECUTION

The contractor shall support the measurement of infrared (IR), visible, and ultraviolet (UV) signatures of weapon system threats to tactical aircraft as well as various terrain backgrounds and targets such as ground vehicles and structures. The contractor shall plan tests, store and assemble the required instrumentation, calibrate and align the instruments, provide for shipment to the appropriate sites, assemble, test and calibrate the instruments, and support the field tests. The contractor will test and verify the communication and data networking capabilities, GPS and IRIG time-tagging functions and remote control functions of data acquisition computers prior to shipment to test sites. The measurements shall include spatial, spectral, and temporal data. The contractor shall be responsible for the on-site maintenance of the instrumentation used for the measurements, and for data security and transmittal. The contractor shall conduct measurements as needed at the Yuma Test Range, White Sands Missile Range (WSMR), Tonopah Test Range (TTR), Naval Air Warfare Center-Weapons Division (NAWC/WD/CL) China Lake, Patuxent Naval Air Station, Naval Research Laboratory (NRL), and at other domestic and foreign sites.

SUBTASK 3.4.3 – LABORATORY AND FIELD TESTING OF PROTOTYPES

The contractor shall execute the test program according to the test plan at the direction of the COR. The contractor shall document all procedures and maintain the data acquired in standard formats. The contractor shall provide quick look reports at appropriate times and shall provide analyses that describe the observed system characteristics. The contractor shall provide for installation of the system into the test platform, shall populate the test site with the necessary instrumentation and test fixtures, and shall execute the tests. The contractor shall keep the COR or his designated test monitor apprised of the progress on a daily basis. The contractor shall prepare a comprehensive report of the test program including all the test data and an analysis of the results.

SUBTASK 3.4.4 – EVALUATION

The contractor shall support the evaluation of prototype systems through the analysis of all test results. The contractor shall perform comparative analyses of the prototypes with respect the existing and other developmental systems. The contractor shall provide detailed and comprehensive reports that present the test results in a clear but concise manner. The reports shall include an executive summary and shall provide recommendations for a path to the most productive utilization of the prototype hardware.

3.5 PROTOTYPE VIS/EO/IR SYSTEM TRANSITION TO THE NAVAL ACQUISITION PROCESS

SUBTASK 3.5.1 – PROVIDE DOCUMENTATION SUPPORTING THE NAVAL ACQUISITION PROCESS

The Contractor shall assist NRL with program management functions and tasks in order to transition Concept & Technology Development Programs to System Development & Demonstration (SDD) for NRL VIS/EO/IR technology programs in real time reconnaissance and electronic warfare. This tasking includes development of budget submissions, briefings, threat studies and analysis, engineering assessments, assistance with preparation of T&E Master Plans (TEMP), Mission Need Statement (MNS) and Operational Capabilities Documents, Acquisition Strategy and Plans, T&E Master plans, development of risk mitigation plans, and assembly of the documentation necessary to verify the Technology Readiness Level of the system. The contractor shall review Future Year Defense Plans and Program Objective Memoranda for technology needs in EO/IR systems for unmanned systems for Air, Surface and Sub-surface applications as well as manned DoD platforms.

3.6 TECHNICAL PROGRAM ASSESSMENT

SUBTASK 3.6.1 – ANTI-TAMPER (AT) TECHNOLOGY AND PROGRAM PROTECTION ASSESSMENT

The Contractor shall identify and delineate NRL Advanced Technologies and developmental systems having Critical Technology (CT); Critical Program Information (CPI); and Program Protection Planning requirements. The Contractor shall identify AT technology suitable for use in NRL advanced development component technology and should assess the maturity of the AT technology use in the protection of NRL developed system and sub-system components. The Contractor shall assist in developing a security classification guide; assist in the development of an AT Plan, including the review of the final AT Plan; assist in the development of an AT Verification Plan and the review of the final AT Verification Plan; and conduct AT Verification reviews of the AT system. CTs are a subset of the systems' Critical Program Information (CPI), which are evaluated for AT protection requirements. Provide technical support for AT planning meetings and reviews to include technical support for Verification and Validation (V&V) testing to verify proper initialization following boot,

proper function of transformation, proper response to input stimulus. Coordinate with the AT Executive agent, SAF/AQL in development of test drivers to provide representative input stimulus, and adapted test instrumentation for collection and analysis of processor output. Provide technical review to the National Security Agency (NSA), Information Assurance (IA) Directorate (VAO/I7) to secure NSA certification of system design and IA techniques.